



Antibacterial Potential of *Rumex vesicarius*: A Phytochemical Perspective

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ABSTRACT

Known as a rich source of physiologically active metabolites, *Rumex vesicarius* has had multiple uses in Arabian traditional medicine. Present study focused on phytochemical profiling and antimicrobial effects of methanolic extracts of *R. vesicarius* leaves and flowers (MRL & MRF). GCMS used for detection of bioactive compounds showed the existence of numerous bioactive compounds such as fatty acids, flavonoids, and steroids. Microbial sensitivity assessed by well diffusion method showed significant activity against both *Gram-positive* and *Gram-negative* pathogens. To isolate the active ingredients and to further investigate their extensive biological functions, more investigation is required.

Keywords: *Rumex vesicarius*, Antibacterial activity, GC-MS analysis, Bioactive compounds.

INTRODUCTION

Rumex vesicarius L (R.V.), commonly known as bladder dock, has long been utilized in

Arabian traditional medicine to treat ailments ranging from digestive disorders and fevers to microbial infections and inflammation^{1,2}. Recent phytochemical investigations have revealed that this desert plant is



rich in bioactive constituents, including phenolics, flavonoids, fatty acids, and steroids^{3,4}. Moreover methanolic extracts of leaves and flowers (MRL & MRF) demonstrated potential antibacterial activity against both groups of gram pathogens⁵. Despite its traditional relevance and initial scientific validation, detailed identification of its bioactive compounds—especially via advanced techniques like GC-MS and comprehensive antibacterial profiling remain limited. Aiming that addressing these gaps could support the development of new plant-derived therapeutics, particularly considering rising antibiotic resistance, this study was therefore undertaken.

MATERIALS AND METHODS

Preparation of Plant Materials

Samples of *R. vesicarius* leaves and flowers were collected from the Hail city of Saudi Arabia and taxonomically authenticated by Dr. N. Hassan, Hafr Al-Batin University.

Extraction Procedure

Finely powdered RL and RF were used for the extraction. At room temperature, 25 g of the powder was extracted with 250 mL of methanol using ultrasonication in four 25-minute cycles over 24 hours in a water bath to enhance extraction efficiency. The mixture was filtered, air dried and used for further analysis⁶.

GC-MS Analysis⁷

Gas Chromatography–Mass Spectrometry (GC–MS) was used to analyze the key bioactive compounds in the MRL and MRF. The analysis was performed on a Thermo Scientific GC–MS–AS 3000 system equipped with an external quality detection detector. Separation was achieved using a TR 5MS capillary column, with helium as the carrier gas at 1.2 mL per min flow rate. For each analysis, two milliliters of the extract diluted in methanol were injected to allow partial separation of the chemical constituents. The mass spectra were recorded and processed using Xcalibur software, and the obtained spectra were compared with reference data from the National Institute of Standards and Technology library and the Main Library.

In vitro Antibacterial Activity

The antibacterial activity of MRL & MRF was tested by well diffusion technique against selected bacterial pathogens on Mueller-Hinton

agar plates using ciprofloxacin (CF) (5 micrograms per disc) as standard antibiotic by method followed by Syed. R.U. *et al.*⁶

RESULTS AND DISCUSSION

Several bioactive compounds were identified by GC-MS analysis that are likely responsible for the observed antibacterial activity, highlighting the plant's potential as a natural source of antimicrobial agents and supporting its traditional medicinal applications. Table 2 and Fig. 3 provide a summary of the major components of the floral extract while the Table 1 and Fig. 2 provide specifics on the important compounds found in the leaf extract.



Fig. 1. *Rumex vesicarius* plant

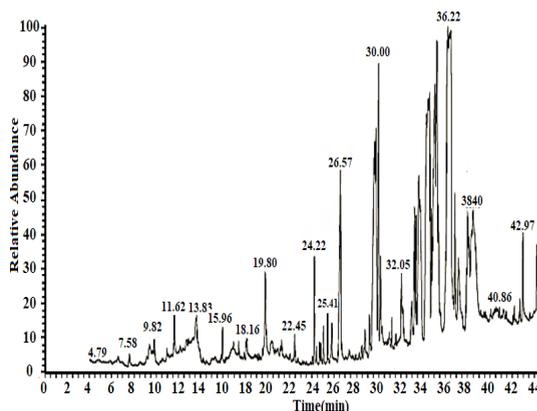


Fig. 2. GC-MS chromatogram of methanolic leaf extract of *R. Vesicarius*

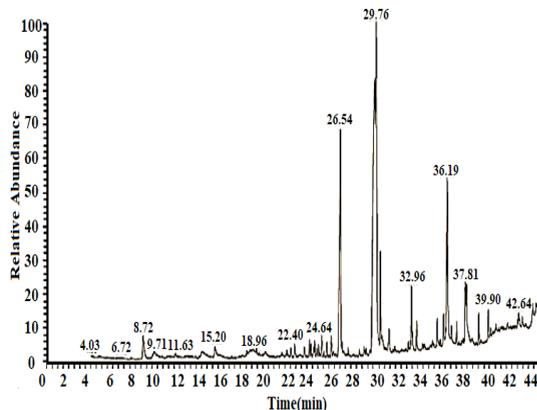


Fig. 3. GC-MS chromatogram of methanolic flower extract of *R. vesicarius*

Table 1: Chemical compositions of Methanolic extract of Rumex leaves via GC-MS

Sr.No	Compound Name	Molecular Formula	Molecular Weight	RT	Area %	Structure
1	9,12,15-Octadecatrienoic acid	C ₂₁ H ₃₆ O ₄	352	38	1.89	
2	Decanoic acid	C ₁₀ H ₂₀ O ₂	172	13.64	0.59	
3	6-Octen-1-ol, 3,7-dimethyl	C ₁₀ H ₂₀ O	156	9.82	0.35	
4	2-Methoxy-4-vinylphenol	C ₉ H ₁₀ O ₂	150	11.62	0.74	
5	Ascaridole epoxide	C ₁₀ H ₁₆ O ₃	184	18.11	0.24	
6	Ethyl iso-allocholate	C ₂₆ H ₄₄ O ₅	436	33.47	0.13	
7	9-Octadecenoic	C ₁₈ H ₃₄ O ₂	282	21.28	0.27	
8	Oleic Acid	C ₁₈ H ₃₄ O ₂	282	18.11	0.24	
9	Neophytadiene	C ₂₀ H ₃₈	278	24.22	1.54	
10	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	C ₂₀ H ₄₀ O	296	24.22	1.54	
11	Phytol	C ₂₀ H ₄₀ O	296	29.18	0.65	
12	9- Hexadecenoic acid	C ₁₆ H ₃₀ O ₂	254	25.41	0.69	
13	9,12,15-Octadecatrienoic acid	C ₁₈ H ₃₀ O ₂	278	25.79	0.67	
14	1-Heptatriacotanol	C ₃₇ H ₇₆ O	536	33.47	0.13	
15	Linoleic acid ethyl ester	C ₂₀ H ₃₆ O ₂	308	31.18	0.48	
16	Glycerol 1-palmitate	C ₁₉ H ₃₈ O ₄	330	35.38	0.91	
17	2,5-Furandione, 3-(dodecenyldihydro-	C ₁₆ H ₂₆ O ₃	266	33.37	1.96	
18	Tetradecanoic acid	C ₁₄ H ₂₈ O ₂	228	22.46	0.48	

*Retention time

Table 2: Chemical compositions of methanolic extract of Rumex flower via GC-MS

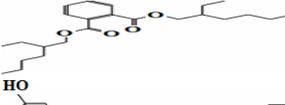
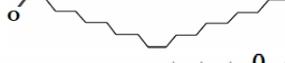
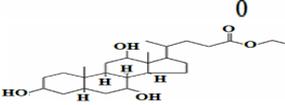
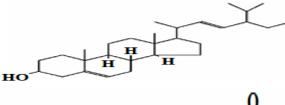
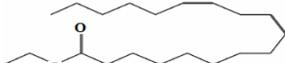
Sr. No	Compound name	Molecular formula	Molecular weight	Retention time	Probability index	%area of curve	Compound structure
1	1,2-Benzenedicarboxylic Acid	C ₂₄ H ₃₈ O ₄	390	35.84	800	1.08	
2	Oleic acid	C ₁₈ H ₃₄ O ₂	282	36.57	806	0.53	
4	Octadecanoic acid, ethyl ester	C ₂₀ H ₄₀ O ₂	312	39.90	843	1.07	
5	Hexadecanoic acid, ethyl ester	C ₁₈ H ₃₆ O ₂	284	37.03	836	0.77	
6	Ethyl iso-allocholate	C ₂₆ H ₄₄ O ₅	436	42.95	771	42.95	
7	Stigmasterol	C ₂₉ H ₄₈ O	412	45.10	748	0.39	
8	Docosanoic acid, ethyl ester	C ₂₄ H ₄₈ O ₂	368	37.03	849	0.77	
9	Linoleic acid ethyl ester	C ₂₀ H ₃₆ O ₂	308	40.57	768	0.39	

Table 3: Results of *in vitro* antibacterial activity

Test micro-organisms	Methanolic leaf extract	Methanolic flower extract	Standard antibiotic Ciprofloxacin (5 mg/Disc)
<i>Staphylococcus aureus</i> ATCC 512477	22.67±1.15	27.67±1.52	33.66±1.24
<i>Staphylococcus epidermidis</i> ATCC 12228	20.34±1.53	25.34±1.53	33.3±1.24
<i>E. coli</i> ATCC 25922	27.67±1.53	30.33±1.154	35.66±0.9
<i>P. mirabilis</i> ATCC 299	16±1	26±1	23.66±1.24
<i>Salmonella choleraesuis</i> ATCC 10708	23.67±1.52	28±4	33.3±1.24
<i>K. pneumoniae</i> ATCC 700603	23.67±4.72	26.33±1.52	26±1.4
<i>E. faecalis</i> ATCC 29212	25.67±3.2	28.33±1.5	25.33±0.4
<i>Pseudomonas aeruginosa</i> ATCC 27853	25±3.6	25.66±1.53	33.3±0.8

#Each value is the mean of 3 batches with standard deviation. All values were compared with standard ciprofloxacin disc by performing Tukey Kramer test (post hoc). All the test values are significantly lesser than the standard ciprofloxacin disc at p<0.05

Decanoic acid⁸, phytol⁹, glycerol 1-palmitate¹⁰, cis-Vaccenic acid¹¹, and Stigmasterol¹² found in the extracts are considered as key contributors for the antibacterial activity. Decanoic acid, identified in the leaf extract, is a medium-chain fatty acid.^{10,13} Its amphiphilic nature enables integration into bacterial membranes, where it disrupts the integrity of the lipid bilayer, increases ion permeability, and ultimately leads to leakage of intracellular contents and cell death.^{13,14}

Phytol, a diterpene present in the leaf extract, has an antibacterial effect by exerting

oxidative stress and producing reactive oxygen species (ROS) in the bacterial cells. This mechanism was specifically observed in *Pseudomonas aeruginosa*, a pathogen that was also inhibited by *R. vesicarius* in this study. The antioxidant potential of *R. vesicarius* may also provide synergistic benefits by modulating host defense systems.⁹

Monoglycerides such as glycerol 1-palmitate are known antibacterial lipids that insert into bacterial membranes and cause cell leakage. Their amphiphilic nature enhances solubility and

interaction with phospholipid bilayers. The detection of glycerol esters in *R. vesicarius* strengthens the hypothesis that lipid derivatives play a central role in its antibacterial potential.^{10,15} The cis-vaccenic acid, detected in the leaf extract, is a monounsaturated fatty acid that is produced in microbial and plant systems. Its incorporation into bacterial membranes alters fluidity and permeability and impairs cell survival. In *E. coli*, cis-vaccenic acid derivatives have been shown to interfere with lipid metabolism, suggesting that their presence in *R. vesicarius* may explain the strong inhibition against *E. coli*.¹¹

The stigmasterol found in the flower extract, was isolated from several medicinal plants and has antibacterial and antioxidant properties.¹⁶ The sterol backbone interferes with microbial membrane enzymes and cell wall synthesis. Its presence may be particularly important for the inhibition of *Gram-positive* cocci, which is consistent with the strong activity of *R. vesicarius* against *Staphylococcus aureus*.¹²

Table 3 summarizes the antibacterial activity profile. The results show that the methanolic extracts of *R. vesicarius*¹⁷⁻¹⁹ leaves and flowers showed the strongest inhibitory effects against most bacterial strains; however, their activity was

still considerably lower than that of the standard antibiotic, ciprofloxacin.

CONCLUSION

Methanolic extracts of *R. vesicarius* leaves and flowers grown in Hail, KSA, contain diverse bioactive components with antibacterial activity against most bacterial strains, though their potency remains notably lower than that of the standard antibiotic, ciprofloxacin. These findings, consistent with earlier research, reinforce the potential of *R. vesicarius* as an antibacterial agent in the context of rising antibiotic resistance. *R. vesicarius* could be a promising source for the development of new antibacterial drugs; however, further investigations are needed to confirm its effectiveness in topical and therapeutic applications and to assess the *in vivo* activity of its active constituents.

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Conflicts of Interest

There are no conflicts of interest declared by the authors.

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